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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/039,319	11/09/2001	Christopher B. Kocon	90065.141001.17732.6317.0	9637
34799	7590	02/20/2004	EXAMINER	
THOMAS R. FITZGERALD, ESQ. 16 E. MAIN STREET, SUITE 210 ROCHESTER, NY 14614-1803			BROCK II, PAUL E	
			ART UNIT	PAPER NUMBER

2815

DATE MAILED: 02/20/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/039,319	Applicant(s) KOCON ET AL.	
	Examiner Paul E Brock II	Art Unit 2815	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 24 December 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 21-23,25 and 34-41 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 21-23,25 and 34-41 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 09 November 2001 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Drawings

1. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, a plurality of gate trenches and the first conductivity as N-type and the second conductivity as P-type must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Claim Objections

2. Claim 21 is objected to because of the following informalities: "a plurality of heavily doped source regions" in line 31 of the claim should be --the plurality of heavily doped source regions--. Appropriate correction is required.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

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4. Claims 21 – 23, 25, 34 – 39, and 41 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

5. The term "substantially coplanar" in claims 21 and 41 is a relative term which renders the claim indefinite. The term "substantially coplanar" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. It is not clear how coplanar the level of gate conductor is with the selected depth of the source regions. Is the level of gate conductor coplanar with the depth of the source regions? How much can the selected depth vary from being coplanar with the gate conductor? No examples of the requisite degree of coplanarity are given in the specification where "approximately coplanar" is defined on page 5, lines 24 – 27. The figures do not provide an accurate measure to what "substantially coplanar" does or does not encompass.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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7. Claims 21, 23, and 35 – 41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Harada (USPAT 5298780, Harada) in view of Okabe et al. (USPAT 5877527, Okabe).

With regard to claim 21, Harada discloses in figures 3 – 14 a process for forming an improved trench MOS-gated device. Harada discloses in figure 3 forming a doped upper layer (2) on a semiconductor substrate, the upper layer having an upper surface and an underlying drain region. Harada discloses in figure 4 forming a well region (3) having a first polarity in the upper layer, the well region overlying the drain region. Harada discloses in figure 5 forming a gate trench mask (21) on the upper surface of the upper layer. It should be noted that the claim does not limit to the gate trench mask to being the upper layer of the mask used to define trenches. Harada discloses in figure 6 forming a plurality of gate trenches (40) extending from the upper surface of the upper layer through the well region to the drain region, the gate trenches having sidewalls and floors. Harada discloses in figure 7 covering the sidewalls and floors with a layer of dielectric material (13). Harada discloses in figures 8 – 11 filling each of the gate trenches to a selected level substantially below the upper surface of the upper level with a conductive gate material (4). It should be noted that completely filling and then removing some of the gate material reads on the claimed filling step. Harada discloses in figure 12 removing the trench mask (21) from the upper surface of the upper layer without removing the layer of dielectric material covering the sidewalls of the trenches. It should be noted that the dielectric layer 13 disclosed in figure 12 of Harada that partially covers the sidewalls of the trench reads on the claim language. Harada discloses in figure 12 forming an isolation layer of dielectric material (15a) on the upper surface of the upper layer and over the dielectric material covering the sidewalls within the gate trench, the isolation layer overlying the gate material and substantially

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filling the trench. Harada discloses in figure 13 removing the isolation layer from the upper surface of the upper layer, a portion of the isolation layer remaining within and substantially filling the trench, and having an upper surface that is substantially coplanar with the upper surface of the upper layer. Harada discloses in figures 12 – 13 forming a plurality of heavily doped source regions having a second polarity in the well regions, the source regions extending to a selected depth from the upper surface of the upper layer where said selected depth is substantially coplanar with the level of the conductive gate material in the trench. Harada teaches in figure 12 wherein the step of forming a plurality of heavily doped source regions comprising ion diffusing. Harada does not teach forming heavily doped source regions by ion implanting, forming a body mask on the upper surface of the substrate, and then forming heavily doped body regions. Okabe teaches in figures 7 – 10 wherein the step of forming a plurality of heavily doped source regions (5) comprises ion implanting the entire upper surface of the substrate with ions of the second polarity (B), then forming a body mask (24) on the upper surface of the substrate. Okabe further teaches in figure 8 forming a plurality of heavily doped body regions (13a) having a first polarity at an upper surface of an upper layer (3), the body regions overlying a drain region in the upper layer, the step of forming a plurality of heavily doped body regions comprising doping the upper surface of the substrate with a dopant of the first polarity, then removing the body mask. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the source region ion implanting of Okabe in the method of Harada in order to more accurately control the doping profile and dose of the source region thereby improving device performance. It would have been further obvious to use the body implants of Okabe in the method of Harada in order to promote electrical contact to the well

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regions. Harada discloses in figures 14 forming a metal contact (6) to the well and source regions over the upper surface of the upper layer. Okabe further teaches in figure 1 forming a metal contact (14) to the body and source regions (5) over the upper surface of the upper layer. It would have been further obvious to one of ordinary skill in the art at the time of the present invention to use metal contact of Okabe in the method of Harada and Okabe in order to make electrical contact to the source and body regions.

With regard to claim 23, Harada discloses in figures 3 – 14 and column 4, lines 50 – 53 wherein the upper layer comprises an epitaxial layer.

With regard to claim 35, Harada discloses in figure 8 and column 5, lines 10 – 12 wherein the conductive gate material within the gate trench is doped polysilicon.

With regard to claim 36, Harada discloses in figure 14 wherein the selected level of gate material in the trench is substantially coplanar with the selected depth of the source regions in the upper layer.

With regard to claim 37, Harada discloses in figures 4 – 14 wherein the first polarity is P and the second polarity is N.

With regard to claim 38, Harada discloses in figures 4 – 14 and column 6, lines 6 – 10 wherein the first polarization is N and the second polarization is P.

With regard to claim 39, Harada discloses in column 6, lines 6 – 10 wherein the device is a power MOSFET.

With regard to claim 40, Harada discloses in figures 3 – 14 a process for forming an improved trench MOS-gated device. Harada discloses in figure 3 forming a doped upper layer (2) on a semiconductor substrate, the upper layer having an upper surface and an underlying

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drain region. Harada discloses in figure 4 forming a well region (3) having a first polarity in the upper layer, the well region overlying the drain region. Harada discloses in figure 5 forming a gate trench mask (21) on the upper surface of the upper layer. Harada discloses in figure 6 forming a plurality of gate trenches (40) extending from the upper surface of the upper layer through the well region to the drain region, the gate trenches having sidewalls and floors. Harada discloses in figure 7 covering the sidewalls and floor with a layer of dielectric material (13). Harada discloses in figures 8 – 11 filling each of the gate trenches to a selected level substantially below the upper surface of the upper level with a conductive gate material (4). Harada discloses in figure 12 removing the trench mask from the upper surface of the upper layer. Harada discloses in figure 12 forming an isolation layer of dielectric material (15a) on the upper surface of the upper layer and over the dielectric material covering the sidewalls within the gate trench, the isolation layer overlying the gate material and substantially filling the trench. Harada discloses in figure 13 removing the isolation layer from the upper surface of the upper layer, a portion of the isolation layer remaining within and substantially filling the trench, and having an upper surface that is substantially coplanar with the upper surface of the upper layer. Harada discloses in figures 12 – 13 diffusing into the surface of the substrate source dopants having a second polarity to form a plurality of heavily doped source regions that extend into the substrate along the sides of the trenches. Harada does not teach the forming heavily doped source regions comprises ion implanting. Okabe teaches in figures 7 – 10 wherein forming heavily doped source regions (5) comprises ion implanting and diffusing. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the ion implanting and diffusing of Okabe in the method of Harada in order to more accurately control

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the doping profile and dose of the source region thereby improving device performance. Harada discloses in figures 14 forming a metal contact (6) to the well and source regions over the upper surface of the upper layer. Harada does not disclose implanting and diffusing into the surface a plurality of heavily doped body regions having a first polarity the body regions overlying the drain region in the upper layer. Okabe teaches in figure 8 implanting and diffusing into the surface a plurality of heavily doped body regions having a first polarity the body regions overlying the drain region in the upper layer. Okabe further teaches in figure 1 forming a metal contact (14) to the body and source regions (5) over the upper surface of the upper layer. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the heavily doped body regions of Okabe in the method of Harada in order to promote electrical contact between the well regions and the overlying source-body metallization layer.

With regard to claim 41, the combination of Harada and Okabe teach the depth of the level of the diffused implants for the source regions is substantially coplanar with the level of the conductive gate material in the trenches.

8. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Harada and Okabe as applied to claim 21 above, and further in view of Baba et al. (USPAT 5578508, Baba).

With regard to claim 22, it is not clear if Harada and Okabe teach wherein the substrate comprises monocrystalline silicon. Baba teaches in figure 3a and column 5, lines 4 – 8 wherein the substrate (10) comprises monocrystalline silicon. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the substrate of

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monocrystalline silicon of Baba in the method of Harada and Okabe in order to use a semiconductor substrate with good electrical characteristics.

9. Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Harada and Okabe as applied to claim 21 above, and further in view of Yamamoto et al. (USPAT 5714781, Yamamoto).

With regard to claim 25, it is not clear if Harada and Okabe teach wherein the source regions surround the body regions and the source regions are separated from each other by trenches. Yamamoto teaches in figures 1a and 1b wherein source regions (4) surround body regions (17) and the source regions are separated from each other by trenches. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the source regions surrounding the body regions of Yamamoto in the method of Harada and Okabe in order to form a vertical MOSFET with a short switching time as taught by Yamamoto in column 1, lines 51 – 54.

10. Claim 34 is rejected under 35 U.S.C. 103(a) as being unpatentable over Harada and Okabe as applied to claim 21 above, and further in view of Baliga (USPAT 5323040).

With regard to claim 34, Harada discloses in figure 7, figure 13, column 4, lines 13 – 21 wherein the dielectric material covering the sidewalls and floor, and forming the isolation layer in the gate trench comprises oxide. It is not clear if Harada and Okabe teach wherein the dielectric material forming the sidewalls, the floor, and the isolation layer in the gate trench comprises silicon dioxide. Baliga teaches in figure 2 and column 1, lines 53 – 66 wherein the

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dielectric material forming the sidewalls, the floor, and the isolation layer in a gate trench comprises silicon dioxide. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the silicon dioxide of Baliga as the sidewalls, floor and isolation layer of Harada and Okabe in order to easily implement gate drive circuitry as taught by Baliga in column 1, lines 53 – 66.

Response to Arguments

11. Applicant's arguments filed December 24, 2003 have been fully considered but they are not persuasive.

12. With regard to applicant's argument that "Harada fails to disclose or suggest filling each of the gate trenches to a selected level substantially below the upper surface of said the level of the substrate with a conductive gate material," it should be noted that the process of Harada disclosed in figures 8 – 11 discloses this step. Applicant does not specifically teach any method for accomplishing filling the gate trenches. Harada clearly discloses one possibility for accomplishing this step. Therefore, applicant's arguments are not persuasive, and the rejection is proper.

13. With regard to applicant's argument that "Harada fails to disclose or suggest forming an isolation layer of dielectric material on the upper surface of said upper layer and over said dielectric material covering said sidewalls within said gate trench," it should be noted that in figure 12, Harada's isolation layer 15a is clearly formed on the upper surface of the upper layer

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and over the dielectric material 13 covering the sidewalls within the gate trench. Nothing in applicant's specification or claims requires that Harada's layer 13 be covering the entire sidewalls within the gate trench. Therefore applicant's arguments are not persuasive, and the rejection is proper.

14. With regard to applicant's argument that "Harada fails to disclose or suggest forming a plurality of heavily doped source regions that extend to a selected depth that is substantially coplanar with the level of the conductive gate material in the trench," it should be noted that neither the claims nor the specification clearly define the scope of "substantially coplanar". Applicant must point out exactly how Harada does not meet the scope of "substantially coplanar" with regard to how it has been defined in the specification. Therefore, applicant's arguments are not persuasive, and the rejection is proper.

15. In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Paul E Brock II whose telephone number is (571) 272-2723. The examiner can normally be reached on 8:30 AM - 5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (571) 272-1164. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9306 for regular communications and (703) 872-9306 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703)308-0956.

Paul E Brock II
February 17, 2004

A handwritten signature in black ink, appearing to read 'Paul E Brock II', with a large, sweeping initial 'P' and a horizontal line extending to the right.